DSN Test and Training System, Mark III-77

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Implementation of the DSN Test and Training System, Mark III-77, is currently in progress. The Mark III-77 system is configured to support DSN testing and training in preparation for the Mariner-Jupiter-Saturn 1977 and Pioneer-Venus 1978 missions, in addition to the on-going in-flight missions. DSN Test and Training System capabilities include functions performed in the Deep Space Stations, Ground Communications Facility, and Network Operations Control Center.

I. Introduction

A. System Definition

The DSN Test and Training System is a multiple-mission system which supports Network-wide testing and training by inserting test signals and data into subsystems of the Deep Space Stations (DSS), the Ground Communications Facility (GCF) and the Network Operations Control Center (NOCC). The system includes capabilities for:

(1) On-site testing of the DSS portion of each DSN system.

(2) Local testing of the NOCC portion of each DSN system.

(3) End-to-end testing of each DSN system, including DSS, GCF, and NOCC functions.

Figure 1 describes the functions, elements, and interfaces of the system. The DSN Test & Training System Requirements through 1980 were published April 15, 1976.

B. Key Characteristics

Design goal key characteristics of the DSN Test and Training System are:

(1) Capability to function without alteration of DSN operational configuration.

(2) Utilization of mission-independent equipment for DSN testing and training functions.

(3) Capability to exercise NOCC, GCF and DSS simultaneously, for end-to-end testing of each DSN system.

(4) Capability to supply test data to all DSN systems simultaneously.

(5) Capability to load Network with combination of actual and simulated data streams.

(6) Accommodation of flight-project-supplied simulation data via GCF.

(7) Accommodation of other data sources, as follows:

(a) Spacecraft test data via JPL Compatibility Test Area (CTA 21).

(b) Spacecraft prelaunch data via Merritt Island, Florida, Spacecraft Compatibility-Monitor Station (STDN (MIL 71)).

C. System Usage

Major testing and training activities supported by the DSN Test and Training System are summarized below:

(1) Prepass and pretest calibrations, readiness verifications, and fault isolation.

(2) DSN implementation activities and performance testing of DSN systems, DSS subsystems, and NOCC subsystems.

(3) DSN operational verification tests to prepare for mission support.

(4) Flight project ground data system tests and mission simulations.

D. Mark III-77 System Implementation

A functional block diagram showing the data-flow and signal-flow paths of the DSN Test and Training System, Mark III-77, is shown in Fig. 2. Implementation to meet the system functional requirements (previously described in Reference 1) is currently in progress. Station-by-station implementation is coordinated with the overall reconfiguration of the Deep Space Station subsystems.

The DSN Test and Training System, Mark III-77, includes the following modifications and additions to the Mark III-75 system:

(1) Modification of the DSS Simulation Conversion Assembly (SCA) to provide capability for short-constraint-length convolutional coding of simulated MJS'77 telemetry data and long-constraint-length convolutional coding of simulated PV'78 telemetry data.

(2) Upgrade of program software for the XDS-910 processor, associated with the SCA, to control new SCA equipment, to generate simulated MJS'77 and PV'78 telemetry data patterns, and to convert MJS'77 and PV'78 project-supplied data from GCF high-speed and wideband data blocks into serial data streams.

(3) Configuring of the DSS Communications Monitor and Formatter (CMF) backup minicomputer to provide the System Performance Test Assembly (SPTA) functions of on-site closed-loop performance testing and validation of the Tracking, Telemetry, Command, and Monitor and Control Systems.

(4) Initial phase implementation of the Network Control Test and Training Subsystem in the Network Operations Control Center (Block III).

II. Deep Space Station Functions

A. DSS Test and Training Subsystem

The functions of the DSS Test and Training Subsystem and the related interfaces are shown in Fig. 3.

1. Telemetry simulation and conversion. The telemetry simulation and conversion functions are performed by the Simulation Conversion Assembly, which is diagrammed in detail in Fig. 4. The digital and analog capabilities of the SCA are itemized in Tables 1 and 2, respectively.

2. System performance test functions. The system performance test functions are performed by the System Performance Test Assembly which is diagrammed in detail in Fig. 5.

B. Receiver-Exciter Subsystem

The Receiver-Exciter Subsystem provides the following test and training functions:

(1) Generation of simulated S-band and X-band downlink carriers.

(2) Modulation of telemetry subcarriers from the SCA onto simulated carriers.

(3) Variable attenuation of simulated downlink carrier signal level under control of the Simulation Conversion Assembly.

(4) Variable control of simulated downlink carrier frequency to permit simulation of doppler shifts.

(5) Provision of a transmitter dummy load for Command System test operations.

C. Antenna Microwave Subsystem

The Antenna Microwave Subsystem provides the following test and training functions:

(1) Routing of simulated downlink carriers to masers and/or receivers.

(2) Mixing of simulated S-band downlink carriers.

D. Frequency and Timing Subsystem

The Frequency and Timing Subsystem provides the following support functions to the DSS Test and Training Subsystem:

(1) Reference frequencies inputted to the SCA.

(2) Time code and reference frequencies inputted to the SPTA.

(3) Generation and distribution of a simulated time signal which can be substituted for the true GMT input to the various DSS subsystems. This capability is provided for realistic mission simulations in support of flight project testing and training activities.

III. Ground Communications Facility Functions

The DSN Test and Training System utilizes the Ground Communications Facility Subsystems for communicating data and information between the Network Operations Control Center (NOCC) or any Mission Operations Center (MOC) and the Deep Space Stations.

A. High-Speed Data Subsystem

The High-Speed Data Subsystem provides the following:

(1) Transmission of text messages, control messages, low-to-medium-rate simulated telemetry data, and simulated command data to any DSS from the NOCC or from any MOC.

(2) On-site loop-back of test data for systems performance testing and readiness verifications in the DSS.

B. Wideband Data Subsystem

The Wideband Data Subsystem provides the following:

(1) Transmission of simulated high-rate telemetry data to the 64-m subnet, the Compatibility Test Area in Pasadena, California, and STDN (MIL-71) at Merritt Island, Florida, from the NOCC or from any MOC having wideband capability.

(2) On-site loop-back of test data for telemetry system performance testing and readiness verification in those Deep Space Stations which have wideband capability.

C. Voice Subsystem

The Voice Subsystem provides operator-to-operator communication of information for purposes of test coordination and monitoring of the DSN Test and Training System status.

IV. Network Operations Control Center Functions

A. NOCC Test and Training Subsystem

Functions and interfaces of the NOCC Test and Training Subsystem are shown in Fig. 6. Subsystem data flow details are further diagrammed in Fig. 7.

1. **Present capabilities.** Test and training capabilities presently implemented in the Network Operations Control Center are as follows:

(1) Selection of stored data blocks and output to the DSS for system readiness verification.

(2) Off-line generation of recordings of high-speed data blocks for testing of the real-time monitors in the NOCC Tracking, Telemetry, Command, and Monitor Subsystems.

(3) Selection and output of prepared Simulation Conversion Assembly text and control messages to the DSS for remote configuration and control of the Simulation Conversion Assembly in support of DSN Operational Verification Tests.

2. **Future capabilities.** Test and training functions that remain to be implemented in the Network Operations Control Center are as follows:

(1) Real-time generation of Simulation Conversion Assembly text and control messages for transmission to the DSS without need for prestorage.

(2) Real-time generation of test data patterns for support of NOCC and DSS testing, without need for prestorage.

B. DSN Test and Training System Control Console

A DSN Test and Training System Control Console in the Network Data Processing Area is planned for future implementation. The console will provide keyboards, a card reader, a magnetic tape unit, volatile displays, and a character printer, so that operation of the Test and Training System will be separate from the operations of the other DSN Systems.

Reference

1. Thorman, H.C., "DSN Test and Training System," in *The Deep Space Network Progress Report 42-30*, pp. 5-15, Jet Propulsion Laboratory, Pasadena, Calif., Nov. 15, 1975.

Table 1. DSS Simulation Conversion Assembly digital telemetry simulation capabilities

Capability	26-meter DSS, MIL 71	64-meter DSS, CTA 21
Maximum number of simultaneous real-time data streams	2 channels	Viking prime mission, 6 channels
		Viking extended mission, 4 channels
		Other missions, 3 channels
Bi-orthogonal (32, 6) comma-free block coding	Viking, 2 channels	Viking, 3 channels
	Other missions, none	Other missions, none
Short-constraint-length convolutional coding (k=7, r=1/2 or 1/3)	Mariner Jupiter-Saturn, rate = 1/2, 2 channels	Mariner Jupiter-Saturn, rate = 1/2, 3 channels
	Future missions, rate = 1/3, 1 channel	Future missions, rate = 1/3, 2 channels
Long-constraint-length convolutional coding (k=32, r=1/2)	Helios, 1 channel	Helios, 1 channel
	Pioneer 10/11, 2 channels	Pioneer 10/11, 2 channels
	Pioneer Venus, 2 channels	Pioneer Venus, 3 channels
Variable rate control	1 bps to 600 ksps on 1 channel	1 bps to 600 ksps on 2 channels
	1 bps to 190 ksps on 1 additional channel	1 bps to 190 ksps on 1 additional channel
Selection of discrete rates	8-1/3, 33-1/3 bps on each of 2 channels (for Viking)	8-1/3, 33-1/3 bps on each of 3 channels (for Viking)

Table 2. DSS Simulation Conversion Assembly analog telemetry simulation capabilities

Capability	26-meter DSS, MIL 71	64-meter DSS, CTA 21
Data and subcarrier signal conditioning, phase-shift keyed modulation	2 subcarriers	Viking prime mission, 6 subcarriers
		Viking extended mission, 4 subcarriers
		Other missions, 3 subcarriers
Subcarrier frequency output	512 Hz to 1.25 MHz, 1/4-Hz resolution	512 Hz to 1.25 MHz, 1/4-Hz resolution
Modulation-index angle control	Controllable from 0 to 89 deg on each subcarrier	Controllable from 0 to 89 deg on each subcarrier
Subcarrier mixing and downlink carrier biphase modulation	Single or dual subcarriers onto each of 2 S-band test carriers or 1 S-band and 1 X-band	Single or dual subcarriers onto each of 3 test carriers or 2 S-band and 1 X-band
Downlink carrier signal level	Attenuation of 0 to 40 dB on each test carrier output	Attenuation of 0 to 40 dB on each test carrier output

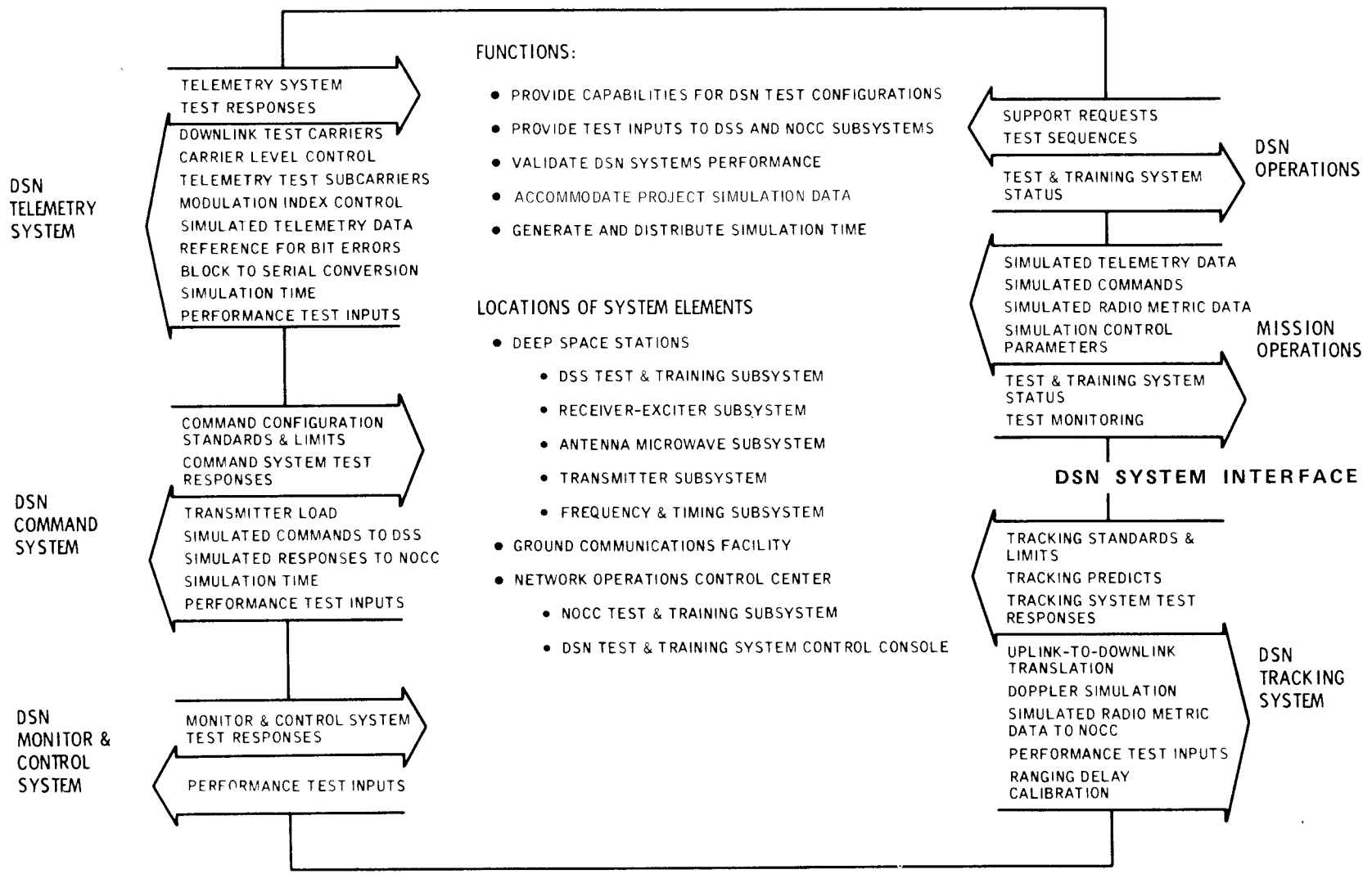

Fig. 1. DSN Test and Training System functions and interfaces

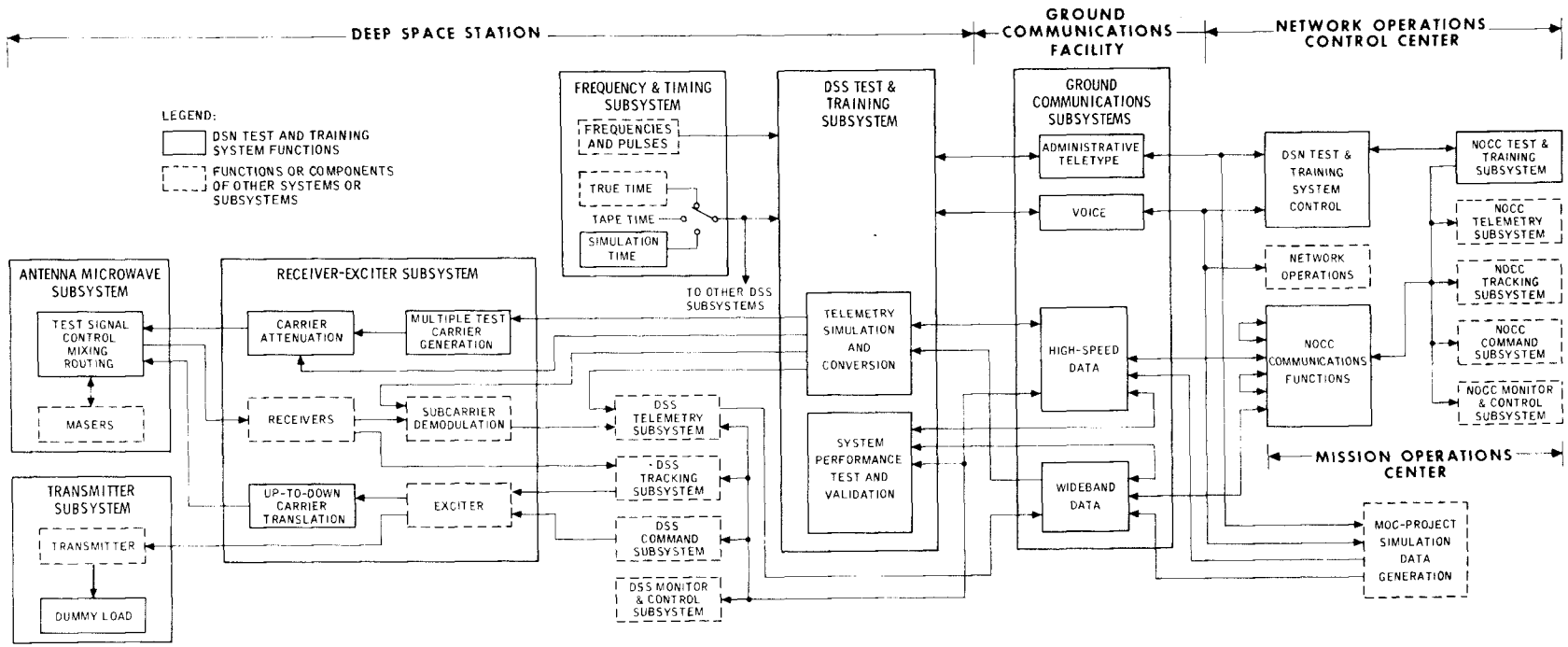

Fig. 2. DSN Test and Training System, Mark III-77, functional block diagram

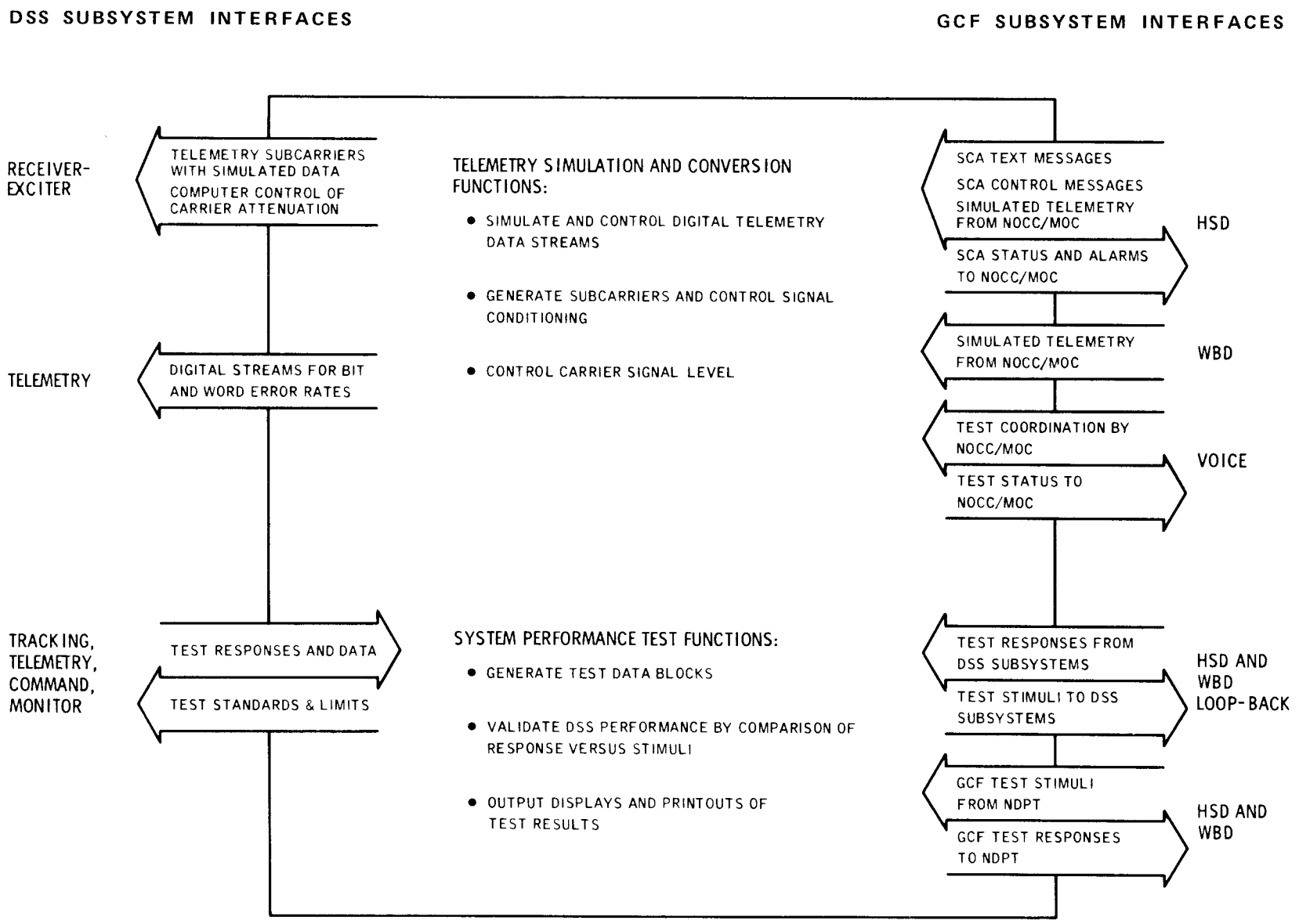

Fig. 3. DSN Test and Training Subsystem functions and interfaces

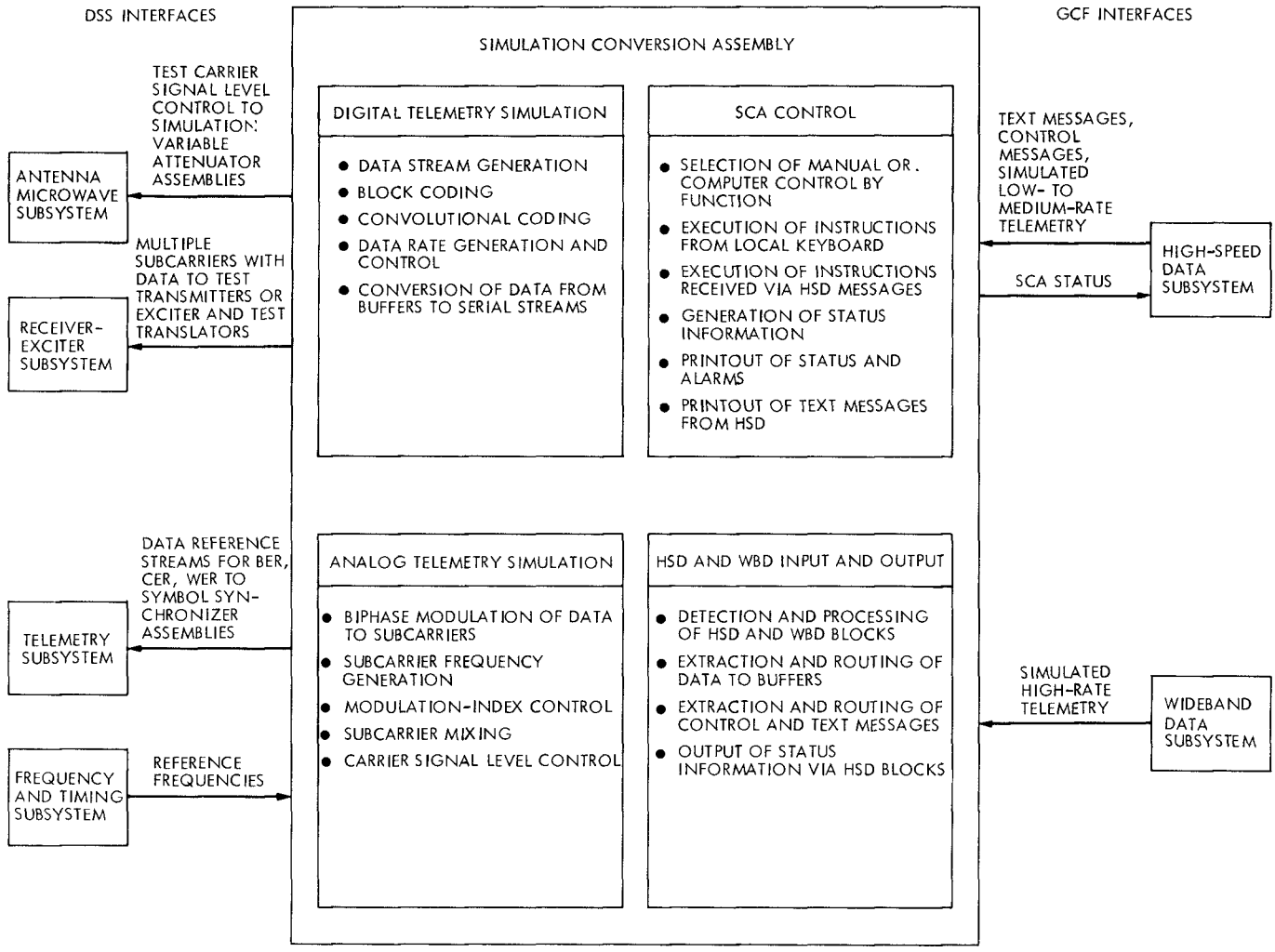

Fig. 4. Simulation conversion assembly functions and data flow

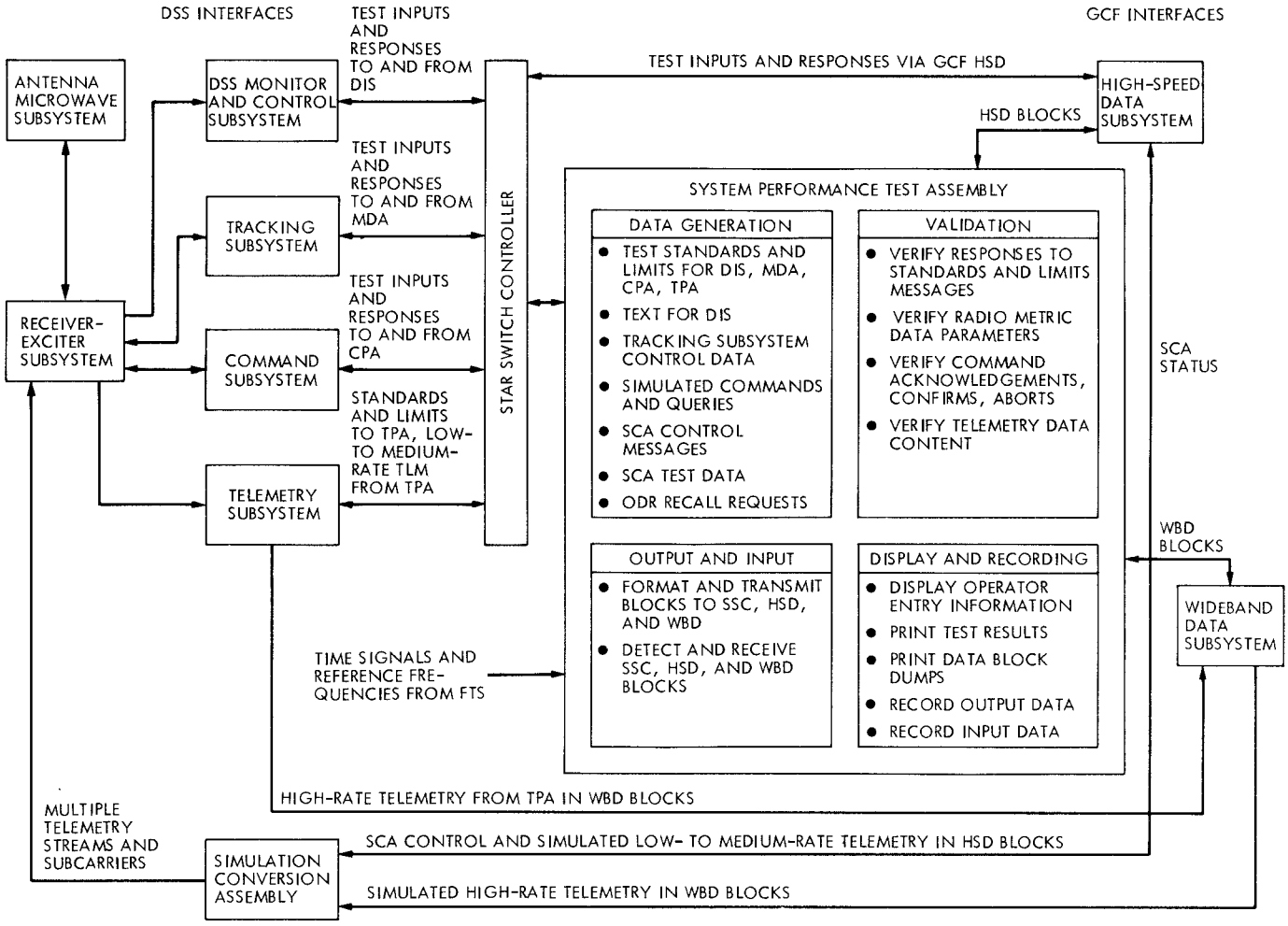

Fig. 5. System performance test assembly functions and data flow

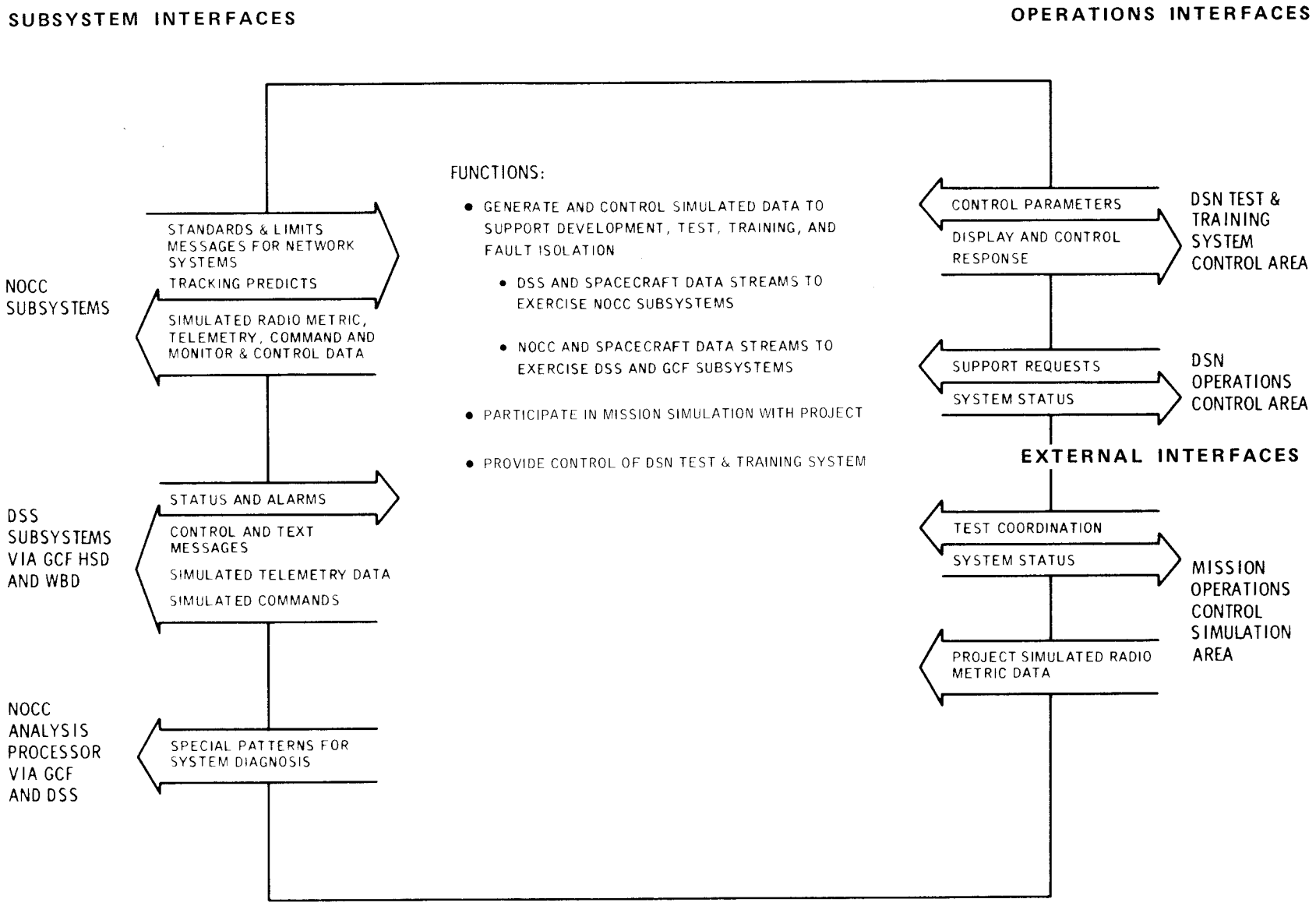

Fig. 6. NOCC Test and Training Subsystem functions and interfaces

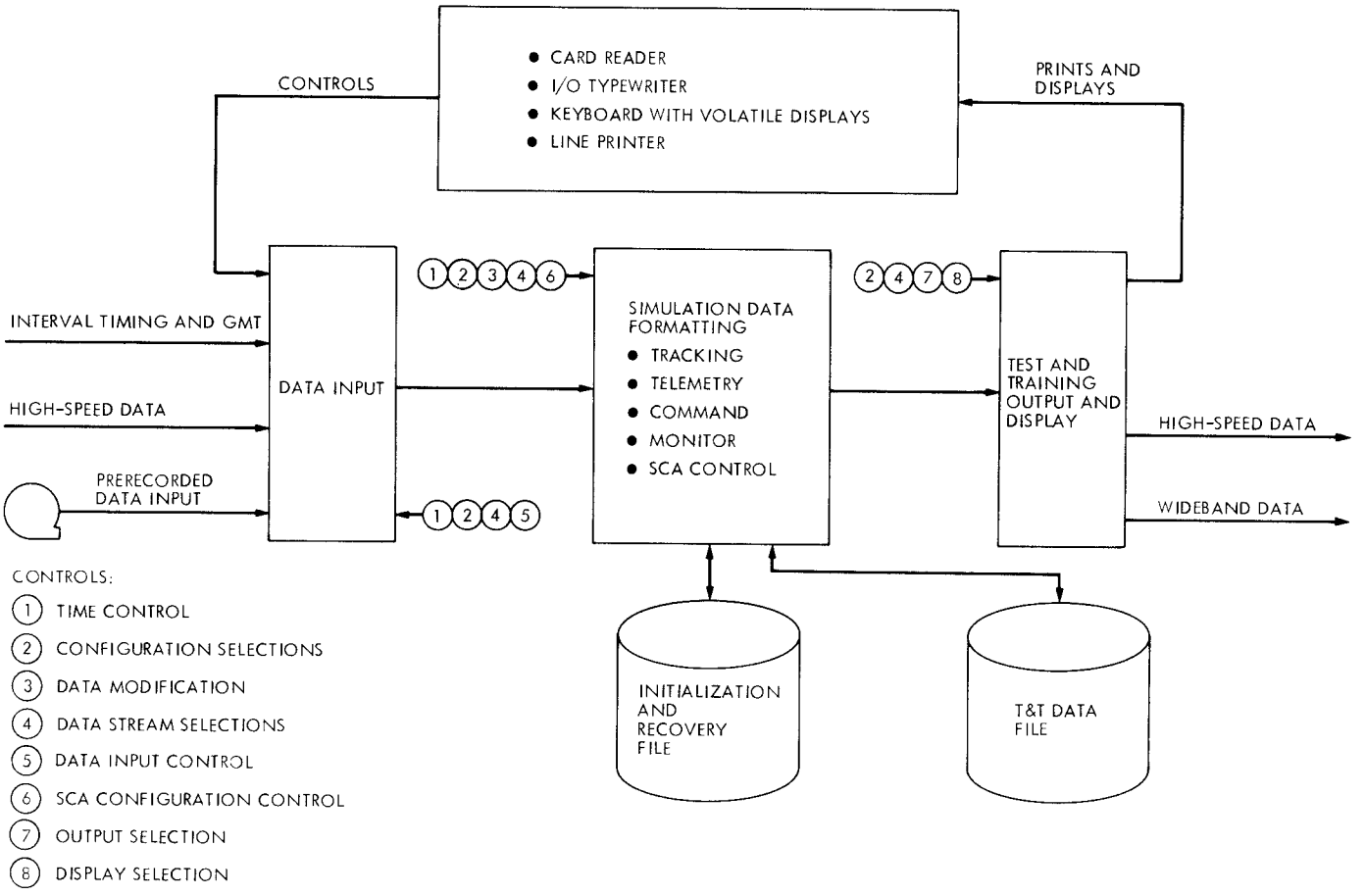

Fig. 7. NOCC Test and Training Subsystem data flow